AOD 33896
Basic PCN 1

Test Equipment Data Package Requirement and Guidelines NASA JSC RGO

Aircraft Operations Division

February 2003

National Aeronautics and
Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

Verify that this is the correct version before use.

Test Equipment Data Package Requirement and Guidelines NASA JSC RGO

February 2003

Basic PCN 1

Approved by

Original Signed By:

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John S. Yaniec
Lead, Reduced Gravity Program

Change Record

Rev.	Date	Process Owner/Extension Alternate/Extension	Description
Basic	May 2002	John S. Yaniec/49211 Dominic Del Rosso/49113	Initial Release
Basic PCN 1	February 2003	John S. Yaniec/49211 Dominic Del Rosso/49113	Incorporate Pressure System changes.

Table of Contents

List of Tables

1 INTRODUCTION

The Reduced Gravity Program, operated by the National Aeronautics and Space Administration (NASA), Lyndon B. Johnson Space Center (JSC) in Houston, Texas, provides a "weightless" environment, similar to the environment of space flight.

1.1 Purpose

The purpose of this guide is to provide a guideline for existing and potential users of the Reduced Gravity Program. This document explains the Test Equipment Data Package, and provides information on pre-flight, post-flight, and in-flight test operations.

1.2 Scope

This work instruction applies to all users and potential users of the Johnson Space Center (JSC) Reduced Gravity Program.

1.3 References

American National Standards Institute (ANSI) Z-136.1 Safe Use of Lasers

AOD 33897, Experiment Design Requirements and Guidelines NASA 931 KC135A

AOD 33898, Interface Control` Document NASA 931 KC135A

AOD Form 70, Detailed Hazard Description

AOD Form 71, Hazard Source Checklist

AOD Form 72, KC-135 Quick Reference Data Sheet

AOD Form 150, Human Research Master Protocol

AOD Form 151, NASA/JSC Human Research Informed Consent

JSC Form 8500, Report of Medical Examination

JSC-20483, JSC Institutional Review Board - Guidelines For Investigators Proposing Human Research For Space Flight And Related Investigations

Standard Form 88, Report of Medical Examination

Standard Form 93, Report of Medical History.

1.4 Reduced Gravity Office Contact Information

Any questions concerning this document, the program, test requirements, test schedules, etc., should be directed to:

Reduced Gravity Office
Building 993
Ellington Field
Houston, Texas 77034
Call 281-244-9874, fax 281-244-9500 or E-mail: zerog1@jsc.nasa.gov

1.5 Information on How to Apply for NASA Microgravity Research Grants

Researchers interested in conducting Reduced Gravity research aboard the KC-135 Reduced Gravity Aircraft must have a NASA grant or be sponsored by NASA or another federal government agency. Information on how to apply for a NASA grant in the areas of Life and Material Sciences can be found at: www.hq.nasa.gov/office/olmsa

1.6 List of Acronyms

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CG	Center of Gravity
DOT	Department of Transportation
FBD	Free Body Diagram
JSC	Johnson Space Center
MAWP	Maximum Allowable Working Pressure
MSDS	Material Safety Data Sheet
NASA	National Aeronautics and Space Administration
RGO	Reduced Gravity Office
TRR	Test Readiness Review
URL	Uniform Resource Locator

2 TEST EQUIPMENT DATA PACKAGE REQUIREMENTS

The following provides a detailed description of the documentation required in the Test Equipment Data Package. A Test Equipment Data Package must be prepared for each experiment proposed for flight on the KC-135. It must be thoroughly completed in accordance with these guidelines and submitted to the Reduced Gravity Office (RGO) no later than six weeks zerog1@jsc.nasa.gov prior to flight. All documentation requirements must be addressed and submitted in the correct format (as stated herein) before an experiment is approved for flight. It is imperative that all sections be addressed. If a section is not applicable to your experiment, do not leave it out. Instead, address the non-applicable section with a brief statement explaining why it is not applicable to your experiment, and move on to the next section. The Test Equipment Data Package requirements presented in this document are the absolute minimum required. These minimums should be exceeded if required to thoroughly explain an experiment.

Note

Any changes to an experiment which occur after the Test Equipment Data Package has been submitted will result in disqualification of the experiment for flight unless the RGO has received appropriate documentation of the change and the Lead Test Director has approved the changes with a signature. The Test Equipment Data Package must follow the section-order presented below:

1. Cover Page
2. Quick Reference Sheet
3. Table of Contents
4. Flight Manifest
5. Experiment Background
6. Experiment Description
7. Equipment Description
8. Structural Analysis
9. Electrical Analysis
10. Pressure Vessel Certification
11. Laser Certification
12. Parabola Details and Crew Assistance
13. Free Float Requirements

14. Institutional Review Board (IRB)

15. Hazard Analysis

16. Tool Requirements

17. Photo Requirements

18. Aircraft Loading

19. Ground Support Requirements

20. Hazardous Material

21. Material Safety Data Sheets (MSDS)

22. Procedures

23. Bibliography

The remainder of this document provides detailed writing instructions for each section of the Test Equipment Data Package.

2.1 Cover Page

The cover page to the Test Equipment Data Package must contain the principal investigator's name, research organization and contact information (e-mail address, phone number, and mailing address), the experiment's title, and the date the package was completed.

2.2 Quick Reference Data Sheet

The AOD Form 72, Quick Reference Data Sheet should be completed in the format shown by selecting the link and included as a dedicated page.

2.3 Table of Contents

The Table of Contents shall list the sections of the Test Equipment Data Package with corresponding page numbers. All pages of the Test Equipment Data Package shall be numbered sequentially.

2.4 Flight Manifest

The Flight Manifest section must list the names of the people flying to perform the experiment. It should include preferred days of flight, state whether or not each flyer has flown parabolas on the KC-135 before, and provide the date(s) of any previous flights.

2.5 Experiment Background

This section of the Test Equipment Data Package should describe why this experiment is being flown on the KC-135. It should be noted whether the experiment is a follow-up of a previous experiment, a preliminary step to a future experiment, or related to a space flight experiment. Technical references detailing related research should be listed here, along with the name of any supporting NASA organization or program.

2.6 Experiment Description

This section of the Test Equipment Data Package shall briefly, but thoroughly, explain the experiment and should be written so that a practicing engineer or scientist can understand the experiment. Science (or engineering) goals should be presented along with a description of the expected results. Expected or actual results for accompanying ground-based experiments should also be presented here.

2.7 Equipment Description

This section must thoroughly describe the equipment required for performing the experiment. The class of hardware must be stated (i.e., Class I, II, III, GSE, etc.). It must include all flight and ground-based equipment including drawings and/or photographs of the equipment, sizes and weights of individual components, and the overall experiment size and weight. A proposed layout of the equipment in the aircraft (for takeoff and landing, as well as during parabolas) is also required, including placement of restraints for the experimenters and required operators, and positions around the experiment. Components of the experiment should be described in detail. Any laser, fluid, chemical, pressure vessel, and free float requirements (include fluid quantities) should be specifically listed. In addition, any component with special handling requirements or special hazards must be described in detail. All items to be taken on-board the aircraft during flight must be listed in this section, including cameras, outreach experiments, tools (see Section 2.16), personal items and mementos, etc. Any special requirements (in-flight or ground based) shall also be described here. Also in this section, please state whether or not the experiment will free float.

2.8 Structural Analysis

Follow the guidelines below to meet the documentation requirements for the structural analysis section of the Test Equipment Data Package submittal of industry accepted verification method(s) (analytical or test).

1. Submit free body diagrams (FBDs) for all g-load conditions listed in the Structural Design Requirements Section of this guide. (FBDs are sketches used to dimensionally locate where g-loads are applied on test equipment.) G-loads will be applied at equipment centers of gravity (CGs).

2. Create a table documenting individual component weights and overall assembly weight. Specify all materials used for test equipment fabrication and their respective allowable load. Specify all fasteners used, weld types, and their location on the test

equipment assembly (this is best accomplished by using a table, detailed drawing/schematic, and/or digital pictures).

3. Submit all design calculations showing comprehensive compliance with all experiment structural design requirements on:

    a. The attachment of components to the frame (prove all components will remain intact and attached to the experiment frame under the g-loads specified in the Structural Design Requirements Section).

    b. The full assembly (prove the frame will withstand the g-loads specified in the Structural Design Requirements Section, induced from its own mass and those masses of the components attached to it).

    c. The floor attachment of the experiment to the aircraft floor (see AOD 33897, Experiment Design Requirements and Guidelines NASA 931 KC135A Section 2.1 for g-loads and allowable aircraft mounting hardware).

    d. If applicable, design calculations proving free-floated hardware can withstand 3 g's in any direction.

    e. The floor load analysis (prove that equipment will not exceed aircraft allowable floor load in-flight).

4. Provide a table that displays the factor of safety/margin of safety result from each structural analysis performed. Label the load case analyzed (i.e., 9g forward load), location of the analysis on the experiment assembly (i.e., laptop computer bracket attachment), and calculated factor of safety or margin of safety.

5. Components may be pull-tested at a component's CG using a properly calibrated tension gauge to simulate g-loads on equipment. This can be used for the structural analysis of lightweight components in determining whether or not attachment brackets can withstand structural design requirements. It is not recommended that this be performed on full assemblies. To properly document pull tests, address the following questions:

    a. How was the test performed (include schematics if necessary)?

    b. What test equipment was utilized and how was it calibrated?

    c. Who performed the test and when?

    d. copies of applicable documentation (TPS's etc.)

2.9 Electrical Analysis

All experiments that use electrical power (including battery power) must provide an electrical analysis formatted in three parts: Schematic, Load Table and Emergency Shutdown Procedures.

2.9.1 Schematic

The analysis should provide a graphical schematic drawing that clearly details the top-level (not the inner circuitry of each component, but the interaction of each component at the box level) electrical design of the experiment. The schematic should include the following:

1. All wiring and electrical devices (including COTS)
2. Each power cord from an aircraft power distribution panel
3. Which aircraft outlets are used, and the voltage and current draw on each outlet (Nominal and Peak current drawn by experiment)
4. A unique identifier (such as a number) matching the actual label on each wire, or wire bundle
5. The gauge number and current carried on each wire (Nominal and Peak current values)
6. A current limiting device and its limiting value for each power cord (ideally, a current limiting device would be installed on each electrical component)
7. A master "kill switch"
8. The grounding method used to bond exposed metal surfaces

2.9.2 Load Tables

All experiments that use electrical power must provide a Load Table for each power source.

Note

Manufacturer supplied batteries used to power camcorders, laptop computers or similar devices should be described in the electrical analysis. A Load Table is not required as long as the device is operated from the battery and the CDTS items have not been modified. A Load Table is required when an AC adapter is used to power the device.

The purpose of a Load Table is to describe the electrical power drawn from each power source and ensure that the source is not overloaded. In the interests of safety, battery powered experiments should complete a Load Table as well.

One Load Table must be provided for each power source in an experiment. For example, if two power cords are driven by an aircraft power distribution panel, then two Load Tables should be completed. If a six-volt battery is used to power part of the experiment, a third Load Table should be completed to describe that circuit as well.

Each table shall provide a description of the power source including the operating voltage and the rated current. The table must provide a detailed list of each load device and the *maximum* current draw of each device. The sum of the *maximum* device currents must not exceed the rated current of the power source (or circuit breaker value).

Ideally, each circuit should be designed so that the total *nominal* current of all devices does not exceed 80 percent of the rated supply current.

2.9.2.1 Example

An example Load Table is given in Table 1. One power cord is used to run the experiment from an aircraft power distribution panel. The cord is plugged into the 115 Volt AC outlet that is circuit breaker protected to 20 Amps on the panel. The cord has a wire gauge (size) of 12. The power source in the example (the aircraft outlet) is used to run four devices, as shown on the right hand column of the table. The total *maximum* current draw of all devices is at the bottom of the column. The total *maximum* current draw must not be greater than the rated current of the supply outlet. Again, each circuit should be designed so that the total *nominal* current of all devices does not exceed 80 percent of the rated supply current.

Power Source Details	Load Analysis
Name : Power Cord A Voltage : 115 VAC, 60 Hz Wire Gauge : 12	Widget 1 - 1 Amp Widget 2 - 5 Amps Widget 3 - 5 Amps Widget 4 - 2 Amps
Max Outlet Current: **20 Amps**	Total Current Draw: **13 Amps**

Table 1. Example Load Table

2.9.2.2 Stored Energy

The analysis must describe any devices used to build a large electrical charge (such as large capacitors or wire coils). The description should provide the maximum voltage of the charge and explain how this energy will be dissipated in the experiment.

2.9.3 Electrical Kill Switch

Finally, each experiment must have emergency shutdown capabilities. A detailed description of the Electrical Shutdown Procedures must be provided in the electrical analysis. The procedures shall describe the "kill switch" incorporated into the design as well as the experiment's reaction to a power loss.

2.9.4 Loss of Electrical Power

In the event of electrical power loss (expected or unexpected), all experiments must fail to a safe configuration.

Researchers should be prepared to demonstrate their experiment's emergency shutdown capability at the Test Readiness Review (TRR).

Experiments may lose electrical power for a number of reasons. A circuit breaker on the aircraft power supply may be tripped (e.g., the experiments emergency "kill switch" may be activated, the aircrew may purposely cut all test power in the event of an in-flight emergency).

2.10 Pressure/Vacuum System Documentation Requirements

All pressure/vacuum systems must comply with the documentation requirements listed below. This documentation is to be included in the Test Equipment Data Package (submitted to the RGO six weeks zerog1@jsc.nasa.gov prior to flight.) All pressure/vacuum systems, regardless of past flight history and classification, must provide accurate documentation on the most current system configuration proposed for flight. All systems will be required to operate at the TRR. Should mission specific parameters prohibit ground operation, prior approval for deviation required.

Category A Documentation Requirements:

Category A pressure/vacuum system documents must be submitted to the RGO via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification.

1. Provide a brief description of the pressure/vacuum system's purpose, components, fluids, fluid quantities, and operating procedures.

2. Provide a schematic showing the location of individual components in the system, including pressure relief devices, gauges, and K-bottles. Label each component in the schematic with a number, and utilize the sample table below for component descriptions.

3. As shown in Table 2 list the individual system components and their design specifications. American Society of Mechanical Engineers (ASME), ANSI, and Department of Transportation (DOT) certified components do not need to be proof-pressure tested. For those columns that do not apply, simply place N/A (not applicable) in the appropriate box:

Schematic Reference #	Component Description	MAWP (psi)	Relief Valve Setting (psi)	Regulator Setting (psi)	Built By	Cert. Test / Calib. Date	Proof Test – Certified By
*1	Nitrogen K bottle	2200	N/A	N/A	ACME, Inc.	May 2, 1999	On "k" bottle DOT sticker
2	Regulator	3000	N/A	200	PDT Co.	Aug 1, 1999	AJN
3	Pressure Relief Valve	500	220	N/A	E & A Indus.	Dec 31, 1999	AJN
4	Stainless Steel Tub	3000	N/A	N/A	M & K Products	May 15, 1999	**P - BCH
5	Reaction Chamber	***250	N/A	N/A	Organization Design	Oct 9, 1999	**H - AJN

Table 2. Pressure System Design Specifications Example

* The number "1" identifies the component labeled "1" on the pressure/vacuum system schematic.
** The "H – AJN" indicates that a hydrostatic proof-pressure test was performed on the reaction chamber by AJN on October 9, 1999. The "P" shown for component 3 indicates a pneumo-static proof-pressure test was performed.
*** The value of 250 MAWP for the reaction chamber is the maximum allowable working pressure (MAWP) designated to that component by engineering analysis. If this component were to be operated using a higher pressure, you would decrease its factor of safety beyond a minimum of 4. Therefore, this system must never be operated at pressures above the lowest MAWP found in the table.

4. Provide detailed drawings of the pressure/vacuum system design. Dimensions, materials, weld joints, and fasteners must be displayed. ASME, ANSI, or DOT certified components are exempt from this requirement.
5. Provide design calculations with FBDs and factor of safety values. ASME, ANSI, or DOT certified components are exempt from this requirement.
6. Include records on system configuration changes, modifications and repairs, inspections performed, etc.
7. All pressure/vacuum systems will be inspected and required to operate at the TRR. They are to operate as proposed in the submitted documentation.

Category B Documentation Requirements:

Category B pressure/vacuum systems will require an Operation and Configuration Control Plan, generated and signed by the NASA JSC Materials and Process Technology Branch. Users will be required to supply necessary information (Suggested Data for Operation and Configuration Control Plan Requests) in order to generate the OCCP in a timely manner.

Category C Documentation Requirements:

Category C pressure/vacuum system documents must be submitted to the RGO via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification. These systems, because of their simplistic design and small potential for damage, require, as a minimum, a general schematic of the system configuration, a table of relief valve pressure settings and component maximum allowable working pressures (MAWP), and a MAWP value for the entire system. All pressure/vacuum systems will be inspected and required to operate at the TRR. They are to operate as proposed in the submitted documentation.

Category D Documentation Requirements:

Category D pressure/vacuum system documents must be submitted to the RGO via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification. These systems require, as a minimum, a general schematic of the system configuration, a table of relief valve pressure settings and component MAWP, and a MAWP value for the entire system. Design calculations for the pressure vessel housing must also be included showing compliance with minimum factors of safety values. All pressure/vacuum systems will be inspected and required to operate at the TRR. They are to operate as proposed in the submitted documentation.

Category E Documentation Requirements:

Category E pressure/vacuum system documents must be submitted to the RGO via the Test Equipment Data Package no later than six weeks prior to the scheduled flight date. Late submission of documentation will result in flight disqualification. These systems, because of their simplistic design and small potential for damage, require, as a minimum, a general schematic of the system configuration, a table of relief valve pressure settings and component MAWP, and a MAWP value for the entire system. All pressure/vacuum systems will be inspected and required to operate at the TRR. They are to operate as proposed in the submitted documentation.

2.11 Laser Certification

The following information must be documented in the laser certification section of the Test Equipment Data Package and submitted to the RGO six weeks prior to the scheduled flight date.

1. State what class of laser is being used with the experiment

2. For all lasers, submit the following information

    a. Laser class, type, and manufacturer

    b. Description of the laser's purpose

    c. Address when the laser will be used during the flight, and for what duration

    d. Description of the containment controls (i.e., describe the protective housing, interlock switches, emergency kill switch, temperature/fire control, protective eyewear, etc.)

3. For lasers categorized in classes 3 and 4, submit the following additional information:

   a. Detailed description of the laser hardware

   b. Description of the laser parameters

   c. Description of the operating and alignment procedures

   d. Description of the operators' training and experience level

   e. Description of the medical surveillance requirements.

2.12 Parabola Details and Crew Assistance

In this section, provide all details on parabola requirements for the flight week. If the research experiment requires partial g levels, (e.g., .01, .05., .1, .16, .38, .5, etc.) indicate how many of each and when, during a normal parabola set of 8 to 10, the partial g parabolas are desired. Keep in mind that flights normally include 10 parabolas per set with a 2 to 3 minute break in between parabola sets. Weather conditions at altitude will dictate how many parabolas are actually performed during a set. It is the researcher's responsibility to inform the RGO if the experiment requires breaks other than the normal 2 to 3 minute break during the turn around. This will impact the number of parabolas that can be done on a given flight. Researchers must also keep in mind that their project may not be the only research project on the flight; concessions must be made by everyone.

The Test Directors will do their best to accommodate all the needs and requests of the researches scheduled to fly that flight, within reason.

Note

Any crew assistance that may be required, both on the ground and during flight, such as free floating an experiment, notification of steady zero g state, etc.

2.13 Institutional Review Board

In this section of the Test Equipment Data Package, please address whether or not an IRB approval is needed for the experiment. Test developers who plan research involving human test subjects, animal test subjects, or biological tests must obtain approval from the JSC IRB. See JSC-20483, JSC Institutional Review Board: Guidelines for Investigators Proposing Human Research for Space Flight and Related Investigations", for details on the IRB process.

Twenty copies of a completed AOD Form 150, Human Research Master Protocol must be submitted to JSC at least six weeks prior to the proposed flight. This protocol must include the equipment safety certification described in the following section, and applicable signed consent forms for each subject (included in AOD Form 151, NASA/JSC Human Research Informed Consent. In addition to equipment safety certification, letter(s) of approval from other IRBs and/or Institutional Animal Care Use

Committees is required. All signed NASA/JSC Human Research Informed Consent forms must include a Layman's Summary of the experiment.

The JSC IRB meets at least once a month with additional meetings scheduled at the call of the Chair. JSC Form 8500 – Report of Medical Examination, Standard Form 88 – Report of Medical Examination, or Standard Form 93 – Report of Medical History should be submitted to:

JSC Institutional Review Board
Mail Code SA
Lyndon B. Johnson Space Center
Houston, Texas 77058

2.14 Hazard Analysis Report Guidelines

These guidelines are intended to help the test developer identify hazards in the test equipment and procedures, and prepare the hazard analysis required for the Test Equipment Data Package. The basic purpose of the Hazard Analysis Report section of the Test Equipment Data Package is to document the safety analysis performed to assure all causes of potential hazard have been addressed and adequate prevention controls have been implemented. The report should be of sufficient depth and detail so that technical personnel can determine if adequate hazard elimination or control has been accomplished or if additional hazard resolution analysis is required. The preparation of the Hazard Analysis Report should begin during the conceptual phase of the experiment as hazards are identified and should continue throughout the experiment's life cycle. The Hazard Analysis Report must be updated whenever changes to experiment design or operations affect a hazard condition.

The Hazard Analysis Report must contain a brief summary of the results of an intensive review of the experiment hardware and planned test operations to identify potential hazard sources inherent in either the experiment equipment or test operations. All hazards, especially those that could cause injury to flight test personnel or adversely affect the flight worthiness of the KC-135 aircraft, should be carefully assessed during this process, even if the possibility of occurrence might seem remote. The evaluator should note that a potential hazard should not be ignored and left unidentified just because stringent precautions have been taken to prevent the hazard from occurring. Such precautions are called "Hazard Controls" and both the hazard and the controls should be identified in the report.

The Hazard Analysis Report consists of the Hazard Source Checklist (AOD Form 71) and a detailed hazard description (AOD Form 70) . The experimenter shall complete the Hazard Source Checklist, enumerating all potential hazards, and its accompanying Detailed Hazard Description. Instructions for the Detailed Hazard Description are provided:

Hazard Title—The title should be concise and descriptive.

Description of Hazard—This section should describe the potential hazard in terms of the risk to flight test personnel and to the flight worthiness of the KC-135 aircraft structure and flight systems. The experimenter should take care to identify the actual hazard as opposed to the hazard cause. For example, the over-pressurization of a tank is a hazard cause, whereas the possible explosion of the tank (with the potential for catastrophic consequences) is the actual hazard. In the same vein, a pressure relief valve attached to the tank would constitute a hazard control.

Hazard Causes—This section of the hazard report should identify and itemize all potential events or factors which could create the specific hazard in question. The number of factors that could induce a specific hazard could conceivably vary from one to perhaps 10 or more. It is important that all possible causes be identified and analyzed. For example, the cause of a tank explosion could conceivably be any of the following factors:

1. Tank under-designed for maximum operating pressure
2. Pressure relief valve failed to open at the correct pressure
3. Tank not equipped with a pressure relief valve
4. One or more defective tank welds
5. Tank pressure gauge reading incorrectly
6. Tank failure because of operating procedure and/or software error

Each of the hazard causes identified above must be countered by one or more specific Hazard Control(s). These controls are discussed in the following section.

Hazard Controls—Particular emphasis must be placed on thoroughly developing the contents of this section of the Hazard Analysis Report. Hazard Control statements must be specific (do not generalize), complete (identify all controls applicable to the specific hazard), and definitive (provide adequate details to fully describe each control). This section must specifically identify the precise Hazard Control(s) utilized (such as design features, safety devices, warning devices, materials selection, and/or special operation procedures) that will eliminate, reduce, counter, or otherwise control the hazard(s) resulting from each Hazard Cause identified. Examples of acceptable Hazard Control statements for two of the Hazard Causes listed above might be:

The pressure vessel has been designed to sustain maximum expected operating pressure with a safety factor of 4.0.

Redundant pressure relief valves, calibrated at xxx psi, will be used on the pressurized tank.

If the experimenter determines a potential hazard for which no suitable Hazard Control is available, the deficiency must be documented and provided to the KC-135 Test Director. This hazard will then be analyzed by NASA for a decision regarding risk acceptance.

2.15 Tool Requirements

In this section, include information regarding the tools that will be brought to the Reduced Gravity facility, tools that will be used on the airplane, and descriptions of the tools that will be borrowed from the RGO.

Include information on how the tools will be controlled, contained, inventoried, and limited in number to an absolute minimum.

It is important to note that each tool must be marked to indicate its owner, have a proper storage location, and be accurately inventoried. Tools needed for flight shall be identified during the TRR briefing for approval and a copy of the tool inventory provided to a Test Director prior to each flight.

Tools must be kept to an absolute minimum. A Test Director must approve all changes to the tool list prior to flight.

2.16 Photo Requirements

Researchers shall inform the RGO of all photographic (still and video) requests for the documentation of the experiment. Please address the following questions:

1. Will a still photographer be requested for photo documentation during flight operations?
2. Will a videographer be requested to video-document your experiment during flight operations?
3. Will your experiment require the S-band downlink? If so, the researcher is responsible for the cost of the S-band downlink. Arrangements for use of the S-band downlink must be made with the RGO **six weeks** zerog1@jsc.nasa.gov prior to the researcher's arrival at Ellington Field.
4. How many camera poles will be required to mount video equipment for sufficient documentation of the experiment? ("Hands free" camera poles can be mounted in the airplane to locate camcorders and cameras at strategic angles for the documentation of the experiment. [link coming soon])

2.17 Aircraft Loading

Use the following guidelines to meet documentation requirements for the Aircraft Loading section of the Test Equipment Data Package.

1. State what type of ground equipment will be needed to load the experiment into the airplane (i.e., forklift, lifting pallet, J-bars , High Lift Truck, etc.) (most equipment is loaded with a forklift and a lifting pallet).

2. Describe the hardware manipulation strategy on the ground and in the KC-135 test cabin (i.e., lifting handles, casters, etc.). If lifting is required, handles must be available for enough personnel to limit the load to 50 lbs per person.

3. List the weights of the assemblies that are to be loaded onto the aircraft. State the base plate area for each assembly in square feet. Calculate and document the amount of load that will be placed on the aircraft floor in pounds per square foot during loading operations. If casters or J-Bars are to be used, calculate and document the weight that will be loaded on each wheel. The RGO will determine if shoring is necessary and will be responsible for implementing all shoring procedures.

2.18 Ground Support Requirements

In this section of the Test Equipment Data Package, describe what will be needed, in terms of ground support, from the RGO. Please address the following questions:

1. What type of power will be needed on the ground for testing research equipment?

2. Is pressurized gas needed (NASA can provide breathing air, nitrogen, helium, argon)? Indicate the number of K-bottles that will be required for ground and flight operations. Any other pressurized gases will be the responsibility of the researcher (MSDS sheets must be provided). K-bottles can be delivered link coming soon) to the:

   Reduced Gravity Office
   Building 993, Ellington Field
   Houston, Texas 77034

3. Will any chemicals that are toxic and/or corrosive be mixed and/or stored? If so, what type of venting will be required?

4. Is access to building 993 (the RGO) requested during hours other than normal business hours?

5. Are there any general tool requests or is there a need for special ground handling equipment?

2.19 Hazardous Materials

Please state whether or not the experiment will be using any toxic, corrosive, explosive, and/or flammable materials. Describe what the material is, how it will be used, and quantities being used. If possible, avoid the use of hazardous materials. If such materials are required for a test, proper containment must be provided. Please describe how you plan to safely contain and handle any hazardous materials. Early contact with the RGO and the JSC Safety Office for discussions on proper use and containment of proposed hazardous materials may prevent delays in getting approval for the use of such materials. If such materials are necessary, provisions for dumping and purging in flight may be required. A current MSDS sheet must be supplied for each hazardous material. For hazard material release calculations, the cabin volume is ≈4346 cubic feet. The cabin air exchange rate is one cabin volume per three minutes.

2.20 Material Safety Data Sheets

In this section of the Test Equipment Data Package, include the MSDS sheets that apply to any chemical, fluid, etc. that the experiment utilizes. MSDS sheets must be provided for all chemicals taken onto JSC property. Copies of MSDS sheets must be kept with the chemicals at their ground-based storage areas.

2.21 Experiment Procedures Documentation

The information presented in this section of the Test Equipment Data Package will describe all of the procedures involved with operating the experiment at Ellington Field. These procedures should be comprehensive, beginning with the hardware arrival at Ellington Field and concluding with its shipment from Ellington Field. These procedures should be broken down in the following order:

Equipment Shipment to Ellington Field

State how equipment will be shipped to Ellington Field (i.e., freight, include shipping company name), when it will be shipped (i.e., month, day, and time), and what storage requirements are needed at Ellington Field to safely store your hardware (i.e., space requirements, temperature, etc). The researchers are responsible for all equipment sent to and from Ellington Field. The RGO will not be responsible for any shipping arrangements. Please see AOD 33898, Interface Control Document NASA 931 KC135A Section 3.3.7 for additional information on the shipping and receiving of equipment to/from Ellington Field.

Ground Operations

State the procedures proposed to set-up and operate your equipment on the ground at Ellington Field. All equipment will be required to operate at the TRR prior to flight. List the ground facilities/equipment required at Ellington Field (i.e., power, tools, forklift, etc.) to operate your equipment.

Loading

State the procedures proposed to load your equipment onto the aircraft (i.e., lifting strategy [link coming soon], tie-down strategy [link coming soon], etc.).

Pre-Flight

State the procedures proposed for pre-flight operations. Are there any special requirements regarding cabin temperatures, power availability, in-flight storage space, etc.?

Take-off/Landing

State any special procedures proposed during take-off and/or landing operations. Will there be any special equipment stowage requirements during take-off and landing? Will there be any power requirements during take-off and landing?

In-Flight

Provide a checklist including all procedures proposed for parabolic maneuvers, including just prior to and after parabolas. Include emergency procedures in this section.

Post-Flight

State any special procedures proposed for readying equipment for the next day's flight.

Off-Loading

State any special procedures proposed for off-loading the equipment from the KC-135. State the shipping arrangements that have been made for the removal of equipment from NASA property.

2.22 Bibliography

Please list any resources (include title, originator, and date) that were referenced in writing the Test Equipment Data Package. Provide footnotes in the body of the Test Equipment Data Package to designate where references were used. For each resource referenced in the bibliography, indicate volumes, chapters, pages, Uniform Resource Locator (URL) addresses, etc.

3 EXCEPTIONS

List any and all exceptions to any RGO (or referenced) documented requirement and/or guideline. Include rationale, description and prior approval or precedence if applicable.

INDEX